marconi instruments

2435

2 GHz DIGITAL FREQUENCY METER

MP MASTER
MA31152

Operating Manual

Operating Manual
H 52435-900F
Vol. 1

2 GHz Digital Frequency Meter 2435

Code Nos. 52435-302A and -303Z

HAZARD WARNING SYMBOLS

The following symbols appear on the equipment.

Symbol	*Type of hazard*	*Reference in manual*
⚠	RF input limit	Chap. 3, para. 1
⚠	AC supply setting	Chap. 2, paras. 6 and 7 Chap. 3, para. 2
⚠	Static sensitive component	See Service Manual

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PRELIMINARIES

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Contents
Notes and cautions

CHAPTERS

1 General information
2 Installation
3 Operation
4-1 Brief technical description
4-2 Technical description
5 Maintenance
6 Replaceable parts
7 Circuit diagrams

These chapters are contained in a separate volume, obtainable as an optional accessory.

Note...

Each page bears the date of the original issue or the code number and date of the latest amendment (Am. 1, Am. 2 etc.). New or amended material of technical importance introduced by the latest amendment is indicated by triangles positioned thus ▶.....◀ to show the extent of the change. When a chapter is reissued the triangles do not appear.

Any changes subsequent to the latest amendment state of the manual are included on inserted sheets coded C1, C2 etc.

NOTES AND CAUTIONS

ELECTRICAL SAFETY PRECAUTIONS

This equipment is protected in accordance with IEC Safety Class 1. It has been designed and tested according to IEC Publication 348, 'Safety Requirements for Electronic Measuring Apparatus', and has been supplied in a safe condition. The following precautions must be observed by the user to ensure safe operation and to retain the equipment in a safe condition.

Defects and abnormal stresses

Whenever it is likely that protection has been impaired, for example as a result of damage caused by severe conditions of transport or storage, the equipment shall be made inoperative and be secured against any unintended operation.

Removal of covers

Removal of the covers is likely to expose live parts although reasonable precautions have been taken in the design of the equipment to shield such parts. The equipment shall be disconnected from the supply before carrying out any adjustment, replacement or maintenance and repair during which the equipment shall be opened. If any adjustment, maintenance or repair under voltage is inevitable it shall only be carried out by a skilled person who is aware of the hazard involved.

Note that capacitors inside the equipment may still be charged when the equipment has been disconnected from the supply. Before carrying out any work inside the equipment, capacitors connected to high voltage points should be discharged; to discharge mains filter capacitors, if fitted, short together the L (live) and N (neutral) pins of the mains plug.

Mains plug

The mains plug shall only be inserted in a socket outlet provided with a protective earth contact. The protective

action shall not be negated by the use of an extension lead without protective conductor. Any interruption of the protective conductor inside or outside the equipment is likely to make the equipment dangerous.

Fuses

Note that there is a supply fuse in both the live and neutral wires of the supply lead. If only one of these fuses should rupture, certain parts of the equipment could remain at supply potential.

To provide protection against breakdown of the supply lead, its connectors, and filter where fitted, an external supply fuse (e.g. fitted in the connecting plug) should be used in the live lead. The fuse should have a continuous rating not exceeding 6 A.

Make sure that only fuses with the required rated current and of the specified type are used for replacement. The use of mended fuses and the short-circuiting of fuse holders shall be avoided.

RADIO FREQUENCY INTERFERENCE

This equipment conforms with the requirements of EEC Directive 76/889 as to limits of r.f. interference.

Chapter 1

GENERAL INFORMATION

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7 Modes of operation
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1 2 GHz Digital Frequency Meter type 2435 2

INTRODUCTION

1. 2435 is a general purpose frequency meter suitable for measuring the frequency of signals in the range 10 Hz to 2 GHz. Frequency coverage is obtained by use of two input channels, 10 Hz to 200 MHz and 200 MHz to 2 GHz. Versatile input buffer circuits ensure reliable operation over a large dynamic range of input levels without the need for a manual input level control.

2. The counter display consists of eight 7-segment bright l.e.d. displays, with automatic positioning of decimal point, leading zeros suppression and indication of overflow, external frequency standard operation and gate open period.

Fig. 1 2 GHz Digital Frequency Meter type 2435

3. Push-button switches enable selection of resolution of 0.01 Hz up to an input frequency of 5 kHz, 0.1 Hz up to 200 MHz and 1 Hz up to 2 GHz. A low-pass filter may be selected by means of a front panel switch if increased noise immunity is required for low frequency measurements.

4. The 2435 can be fitted with either of two types of frequency standard. A temperature-compensated crystal oscillator frequency standard is fitted to version no. 52435-302A. An oven-controlled crystal oscillator frequency standard is fitted to version no. 52435-303Z. See para. 10 for details.

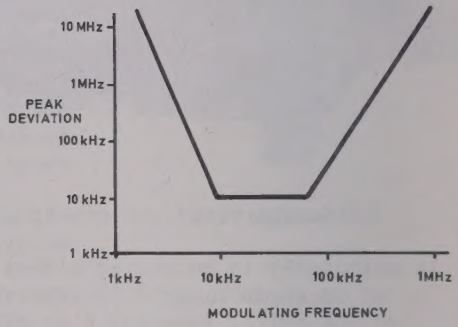
5. A data interface kit is available which enables 2435 to receive control signals from, and to transmit measurement data to, an external measuring system.

PERFORMANCE DATA

Characteristic	*Performance*
6. Input	Two inputs are provided covering a total frequency range of 10 Hz to 2 GHz. A switch enables selection of Channel A or Channel B.
Input Channel A	
Frequency range :	200 MHz to 2 GHz.
Dynamic range :	AGC provides capability for handling signals over a dynamic range of at least 26 dB.
Sensitivity :	-13 dBm (50 mV r.m.s. p.d. into 50 Ω).
Maximum input :	+13 dBm (1.0 V r.m.s. p.d. into 50 Ω). Maximum d.c. input 100 V.
Overload limit :	10 W continuous incident power. 100 W pulse (max. pulse length 1 µs, duty cycle equal to or less than 10%).
Input impedance :	50 Ω.
Input v.s.w.r.:	Less than 2:1.
AM tolerance :	Up to 50% modulation depth at signal levels between -7 dBm and +7 dBm at modulating frequencies below 1 kHz.
FM tolerance :	Worst case: At least 5 kHz peak deviation at any modulating frequency (single tone) at any carrier frequency within the frequency range at any level between -7 dBm and +7 dBm.

Characteristic *Performance*

Typical: At any carrier frequency within the frequency range and at any level between -7 dBm and +7 dBm the performance is better than that shown in the graph.



Input Channel B

Frequency range : 10 Hz to 200 MHz.

Dynamic range : AGC provides capability for handling signals over a dynamic range of up to 90 dB.

Sensitivity : 10 mV r.m.s. (sine wave) from 10 Hz to 70 MHz.

25 mV r.m.s. (sine wave) from 70 MHz to 200 MHz.

Maximum input : 260 V r.m.s. (sine wave) at 50 Hz. 5 V r.m.s. (sine wave) at 200 MHz. (Degradation from 50 Hz to 200 MHz approx. 1.3 x 10^{-6} V/Hz.)

Maximum d.c. : 250 V.

Characteristic	*Performance*
	Maximum a.c. + d.c.: 250 V r.m.s. at 50 Hz.
Input impedance :	Greater than 1 MΩ in parallel with less than 25 pF. AC coupled via 0.1 μF.
Input filter :	Switchable low-pass filter reduces sensitivity above 10 kHz to improve noise immunity when counting l.f. signals. (Attenuation at least 20 dB above 100 kHz.)

7. Modes of operation

Six push buttons select the following ranges and indicate resolution and readout units:

1. 1ms gate providing 1kHz resolution.
2. 10ms " " 100Hz "
3. 100ms " " 10Hz "
4. 1s " " 1Hz "
5. 10s " " 0.1Hz "
6. 1s " " .01Hz "

Notes...

(1) Range 6 operates only on channel B up to 5 kHz.

(2) Range 5 is specified only on channel B.

(3) Ranges 1 to 4 operate on both channels over full frequency range.

(4) Gate times apply directly to channel B only. For channel A the gate times are increased by a factor of approximately

$$\frac{\text{input frequency}}{35\ \text{MHz}}$$

Characteristic	*Performance*
8. Display	8 digit with memory (7-segment l.e.d. of 8 mm height).
Features :	Decimal point automatically selected. Lamp indicates overflow. Leading zeros suppressed. Digit check facility - releasing all range buttons displays all segments and decimal points.
Display time :	Readout retained during gating period.
Gate indication :	Lamp indicates gating period.
9. Accuracy	
Basic accuracy :	±1 count ± frequency standard error (except for ratio measurements which is ±2 counts ± frequency standard error).
Frequency standard :	Internal oscillator or external input automatically selected. Application of external signal overrides internal oscillator. Front panel lamp indicates when external standard is accepted.
External standard input :	
Frequency :	1 MHz (sine or square wave). Usable from 10 kHz to 1 MHz for ratio measurements on channel B.
Input level :	150 mV r.m.s. sine wave minimum up to approximately 10 V r.m.s. sine wave maximum.
Impedance :	100 kΩ minimum, a.c. coupled.

Characteristic	*Performance*
10. Internal standard	
Adjustment range :	Control accessible through rear panel allows adjustment of internal standard to compensate for ageing.
Stability	
Temperature compensated crystal oscillator type, code no. 52435-302A	
Temperature :	Less than ±1.5 p.p.m. over operating range of 0°C to 40°C.
Age rate :	Less than ±0.4 p.p.m. nominal per month after 1 month continuous use.
Oven controlled crystal oscillator type, code no. 52435-303Z	
Temperature :	Less than ±0.1 p.p.m. over operating range of 0°C to 40°C.
Age rate :	Less than ±0.4 p.p.m. nominal per month after 1 month continuous use.
Auxiliary output :	Internal standard at 1 MHz available from rear panel socket.
Level :	Greater than 100 mV p-p into 50 Ω (approx. 4 V e.m.f.).
Impedance :	Approx. 2 kΩ.
11. Data interface	BCD data output and remote range selection are available using the data output lead (see accessories). This lead, installed by the user, provides the following connections.

Characteristic	*Performance*	
	Mnemonic	*Function*
	ABCD, BBCD, CBCD, DBCD	BCD output, bit parallel byte serial.
	DEN	Display enable input
	OFL	Overflow indication output.
	NCLR	Counter and display clear input.
	NINH	Counter gate control may be used as an output to monitor gate or as an input to control gate.
	SCX	External display scan input, also controls data output multiplexing.
	SCR	Internal/external multiplexing switch and multiplexer reset input.
	DPT	Decimal point output.
	LZS	Leading zeros suppression output.
	ATB, BTB, CTB, DTB, ETB	1 of five range selection input.
	NREM	Remote operation enable input.
	FREQ	Select 1.f. multiplier.

12. Environmental

Rated range of use :

Temperature : $0^{o}C$ to $40^{o}C$.

Conditions of transport and storage :

Temperature :	$-40^{o}C$ to $+70^{o}C$.
Humidity :	Up to 90% relative humidity.
Altitude :	Up to 2500 m (pressurised freight at 27 kPa (3.9 lbf/in^2) differential).

Limit range of operation:

Temperature :	$0^{o}C$ to $55^{o}C$.

13. Safety — Complies with IEC 348.

14. Power requirements

Voltage :	Switchable a.c. voltage ranges, (limiting values) 95 - 120 V 105 - 132 V 190 - 240 V 210 - 264 V
Frequency :	45 to 440 Hz.
Consumption :	Approx. 15 VA.

15. Dimensions and weight

Height :	108 mm (4.25 in) overall.
Width :	215 mm (8.5 in) without handle. 256 mm (10.1 in) with handle.
Depth :	338 mm (13.3 in) overall.
Weight :	4.5 kg (10 lb).

16. Accessories

Supplied :	Mains lead 43123-076Y. Operating manual H 52435-900F, Vol. 1, 46881-357T.
Optional :	Cover (lid) 54124-022L.
	BNC to BNC lead, (1.5 m, 50 Ω), 43129-012S.
	Rack mounting kit, 46883-401T.
	Data interface kit, 46883-405C.
	20 dB 5 W attenuator 6534/4.
	Telescopic aerial to BNC plug, 54421-001N.
	N type lead (0.5 m, 50 Ω), 43126-026A.
	Coaxial adaptor (50 Ω N male to BNC female), 54311-093X.
	Service manual H 52435-900F, Vol. 2, 46881-358P.

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Chapter 2

INSTALLATION

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1 Unpacking and repacking
3 Mounting arrangements
5 Mains supply
7 Fuses
8 Safety testing
9 Data interface

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UNPACKING AND REPACKING

1. Retain the packing materials and the packing instruction note (if included) in case it is necessary to reship the instrument.

2. If the instrument is to be returned for servicing attach a label indicating the service required, type or model number (on rear label), serial number and your return address. Pack the instrument in accordance with the general instructions below or with the more detailed information in the packing instruction note.

(1) Place a pad in the bottom of the container.

(2) Place pads in the front and rear ends of the container with the plywood load spreader(s) facing inwards.

(3) Put the polythene cover over the instrument and place it in the container with the front handles and rear projections (where applicable) against the plywood load spreaders.

(4) Place pads in the two sides of the container with cushioning facing inwards.

(5) Place the top pad in position.

(6) Wrap the container in waterproof paper and secure with adhesive tape.

(7) Mark the package FRAGILE to encourage careful handling.

If the original container or materials are not available, use a strong double-wall carton packed with a 7 to 10 cm layer of shock absorbing material around all sides of the instrument to hold it firmly. Protect the front panel with a plywood or cardboard load spreader; if the rear panel has guard plates or other projections a rear load spreader is also advisable.

MOUNTING ARRANGEMENTS

3. If a plastic cover is fitted over the instrument, it should be removed before the instrument is used.

4. The instrument is supplied ready for bench mounting, but a rack mounting tray is available as an accessory. It consists of a housing with two compartments either of which will accommodate 2435 without its case. The other compartment is covered with a blank front panel and can be used to house a second instrument of similar size. Full fitting instructions are supplied with the tray.

MAINS SUPPLY

5. The mains lead supplied is a free cable fitted at one end with a socket which connects to the 3-pin plug on the instrument's rear panel. When fitting a mains plug to the lead, make sure that the following colour-coding is observed :

Live - Brown
Neutral - Blue
Earth - Green/Yellow

6. Before connecting the instrument to the mains supply, check that rear panel AC SUPPLY switches are correctly set and that the fuses fitted are the correct rating. The instrument is normally despatched with the AC SUPPLY switches set to 230/240 V. To change to another supply voltage, remove the rear panel switch locking plate, and change the switch positions so that the locking plate can be refitted to reveal the required supply voltage marked on the rear panel.

Fuses

7. The correct fuse rating for any supply voltage is also marked on the rear panel. The supply voltage ranges available and their corresponding fuse ratings are as follows. (Fuses are time-delay type.)

230-240 V - 250 mA (T)
210-220 V - 250 mA (T)
115-120 V - 500 mA (T)
105-110 V - 500 mA (T)

SAFETY TESTING

8. Where safety tests on the mains input circuit are required, the following procedures can be applied. These comply with BS 4743 and IEC Publication 348. Tests are to be carried out as follows and in the order given, under ambient conditions, to ensure that mains input circuit components and wiring (including earthing) are safe.

(1) Earth lead continuity test from any part of the metal frame to the bared end of the flexible lead for the earth pin of the user's mains plug. Preferably a heavy current (about 25 A) should be applied for not more than 5 seconds.

Test limit : not greater than 0.5 Ω.

(2) 500 V d.c. insulation test from the mains circuit to earth and other circuits.

Test limit : not less than 2 MΩ.

DATA INTERFACE

9. A data interface kit is available as an optional accessory, see Chap. 1, para. 16. The kit contains a connector assembly and installation instructions. The connector assembly consists of the data interface connector wired to a ribbon cable which divides into five branches, each of which is wired to a miniature socket.

10. The data interface connector is mounted in the aperture provided by removal of the blanking plate on the rear panel of the instrument. The sockets plug into miniature plugs on the printed circuit board according to the instructions supplied. The data interface socket is then ready to provide a link between the control and readout circuitry of 2435 and outside control and data handling circuits.

11. Control signals set the frequency meter to remote, set the counter range, clear and trigger the count sequence and enable or disable the display. The resulting frequency reading is available as serial b.c.d. data corresponding to the display digits which are multiplexed into the interface by external synchronizing signals. Decimal point position and suppressed leading zeros data are mutiplexed simultaneously.

12. The data interface lines as shown in Fig. 1 carry positive true t.t.l. logic levels, unless otherwise stated below. Their functions are as follows.

DBCD	BCD coded data output (most significant bit).
CBCD	BCD coded data output
BBCD	BCD coded data output
ABCD	BCD coded data output (least significant bit).
DEN	Display enable input.
OFL	Overflow output.
NCLR	This input requires two logical '0' pulses of at least 1 µs duration, at least 50 µs apart to clear the counter system and display.
NINH	A logic '0' at this input closes the counter gate. When this input goes to logical '1' a new cycle is started.

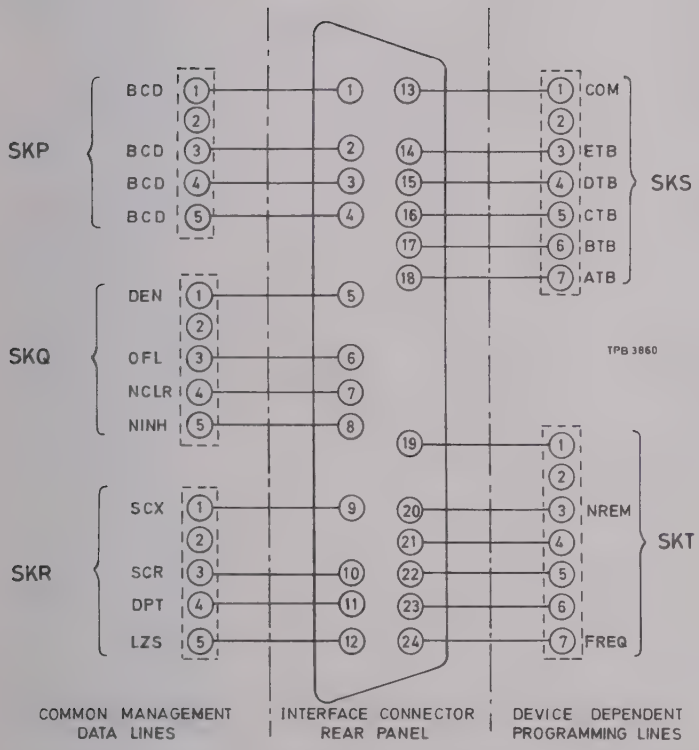

Fig. 1 Data interface pin assignment

SCX SCR	A rising edge at this input advances the multiplexer. When this input is logical '1' the multiplexer operates from control signals generated in the instrument. When this falls to logical '0', the multiplexing of the data output lines is set to the most significant digit.
DPT	Output for left-hand decimal points, multiplexed.
LZS	Output for leading suppressed zeros.
ETB	Input for range control, 1 kHz resolution.
DTB	Input for range control, 100 Hz resolution.
CTB	Input for range control, 10 Hz resolution.
BTB	Input for range control, 1 Hz resolution.
ATB	Input for range control, 0.1 Hz resolution.
FREQ	Input for range control, .01 Hz resolution.
NREM	Remote enable input, negative true, enables remote operation, disabling front panel controls. A plug-in wire link which holds the instrument in local mode should be removed to allow the instrument to respond to NREM and operate in the remote mode.

Chapter 3

OPERATION

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2 Rear panel
3 Operating procedure
3 Frequency measurement
4 Ratio measurements
6 LP filter
7 Self check procedure
10 Display digit check

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2 Rear panel 4
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EXTERNAL FEATURES

Front panel

1. Refer to Fig. 1 for front panel details.

(1) SUPPLY switch - Turn clockwise to switch on. Illuminated display indicates supply is on.

(2) OVERFLOW indicator - Shows that the most significant digit or digits have overflowed the display.

(3) EXT. STD. indicator - Shows that external frequency standard is in operation.

(4) GATE indicator - Shows period during which gate is open.

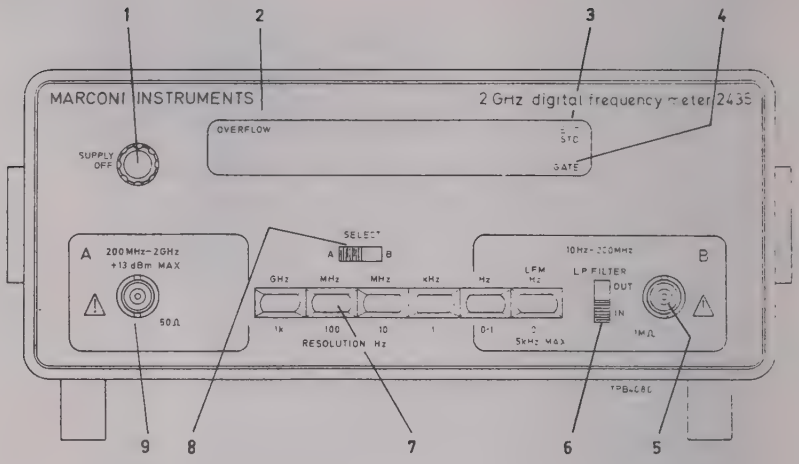

Fig. 1 Front panel

(5) 10 Hz - 200 MHz input socket Channel B, BNC connector.

⚠ *CAUTION*

Do not exceed the maximum a.c. or d.c. levels stated in Chap. 1, para. 6.

(6) LP FILTER switch - Enables selection of filter to improve noise immunity for low frequency measurements.

(7) RESOLUTION and readout unit switches - Six interlocking push-buttons select gate time, resolution and decimal point position.

Ranges GHz, MHz, MHz and kHz operate on both input channels. Range Hz (0.1) is for use with Channel B inputs only. Range LFM Hz (low frequency multiplier) operates only on Channel B up to 5 kHz and gives .01 Hz resolution with a 1 s gate time.

(8) SELECT A/B switch - Enables selection of Channel A or Channel B inputs.

(9) 200 MHz - 2 GHz input socket Channel A, 50 Ω, N type connector.

⚠ *CAUTION*

Do not exceed the maximum a.c. or d.c. input levels stated in Chap. 1, para. 6.

Rear panel

2. Refer to Fig. 2 for rear panel details.

(1) 1 MHz STD. EXT. socket - 50 Ω BNC connector accepts 1 MHz external standard frequency input. Provided that the external standard frequency signal is of sufficient amplitude, the instrument automatically switches over from its internal standard frequency, but will switch back to it should the amplitude of the external standard frequency fall below the minimum limit.

CAUTION

Do not exceed 10 V at the EXT. IN socket.

(2) 1 MHz STD. INT. socket - 50 Ω BNC connector provides internal standard frequency output.

(3) ADJUST INT. STD. - A screwdriver adjustable 10-turn trimmer allows fine adjustment of the internal frequency standard.

(4) AC SUPPLY switches - Position of locking plate allows switch selection of supply voltage and reveals correct fuse rating.

(5) FUSES - Both the live and neutral supply conductors are protected by fuses. Refer to Chap. 2, para. 7 for details.

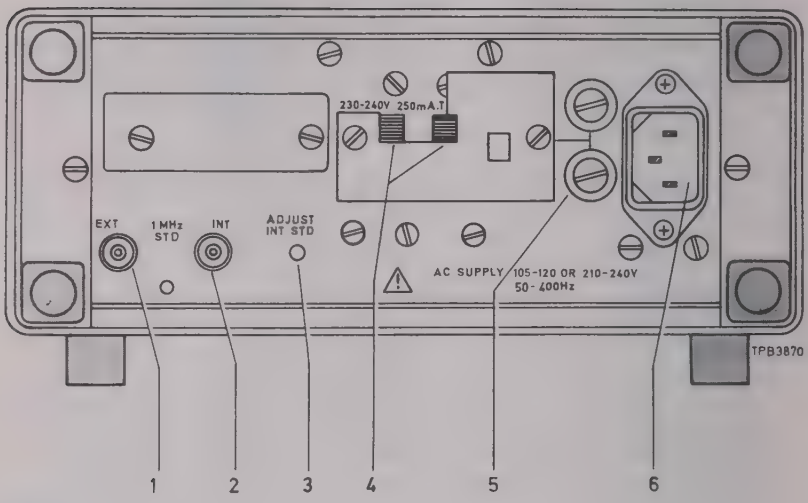

Fig. 2 Rear panel

(6) AC SUPPLY plug - Suitable for supply voltages from 105 V to 240 V a.c., 50 to 400 Hz.

⚠ *CAUTION*

Ensure that AC SUPPLY switches are correctly set before connecting mains supply.

OPERATING PROCEDURE

Frequency measurement

3. Refer to Fig. 3 which shows the counter gate time and display time for each of the RESOLUTION push-buttons.

(1) Connect the signal to be measured to the channel input socket appropriate to the signal's frequency, and check that the setting of the SELECT input switch is correct.

(8) SELECT A/B switch - Enables selection of Channel A or Channel B inputs.

(9) 200 MHz - 2 GHz input socket Channel A, 50 Ω, N type connector.

⚠ *CAUTION*

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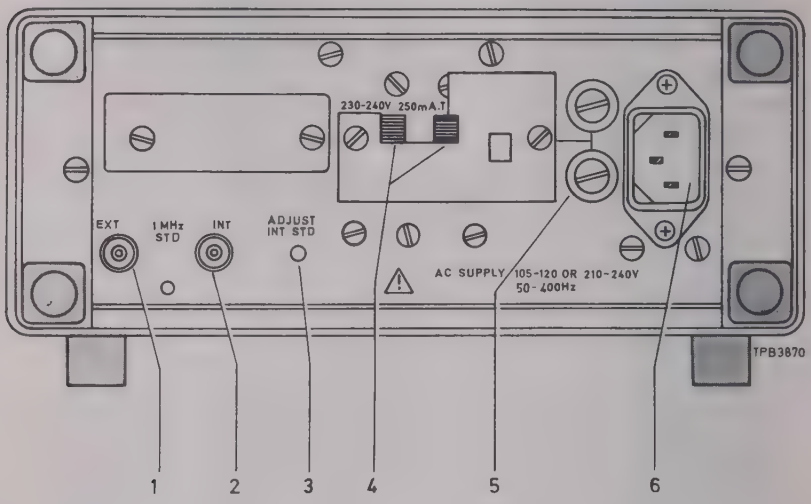

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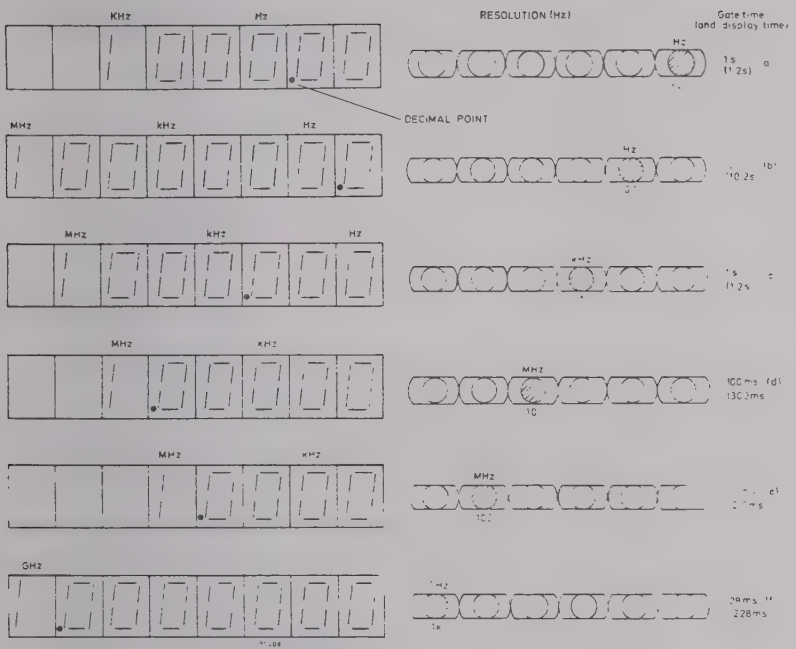

Fig. 3 Display data for self check procedure (input signal (a) 1 kHz; (b-e) 1 MHz; (f) 1 GHz)

(2) If an external frequency standard is to be used, check that the EXT. STD. indicator is lit.

(3) Select the required RESOLUTION. Note the position of the decimal point on the display.

(4) If the OVERFLOW indicator lights, select a faster gate time. If greater resolution is required, select a slower gate time. See Fig. 3.

Ratio measurements

4. The ratio of two frequencies may be measured using Channel B and the following technique.

(1) Connect the first signal to the Channel B input socket. Ensure that frequency is within the range 10 Hz to 200 MHz.

(2) Connect the second signal to the rear panel 1 MHz STD. EXT. socket. Ensure that frequency is within the range 10 kHz to 1 MHz.

CAUTION

Do not exceed 10 V at the 1 MHz STD. EXT. socket.

(3) Check the EXT. STD. indicator to see that the instrument is now using the signal at the 1 MHz STD. EXT. socket as its timing source.

(4) Select 10 Hz RESOLUTION. The display shows the ratio of INPUT frequency divided by EXT. IN frequency. For example :

INPUT = 500 kHz	DISPLAY = 50.00000
EXT. IN = 10 kHz	(Gate time 10 s)
INPUT = 2 kHz	DISPLAY = .00200
EXT. IN = 1 MHz	(Gate time = 100 ms)

5. For measuring large ratios, follow the procedure given above, and note the position of the significant digits in relation to the decimal point. Then switch to 1, 0.1 or .01 Hz for greater resolution. For example :

RESOLUTION = 10 Hz	
INPUT = 12.5 Hz	DISPLAY = .00001
EXT. IN = 1 MHz	(Gate time = 100 ms)
Switch to RESOLUTION = 0.1 Hz	DISPLAY = 12.5
	(Gate time = 10 s)

Note that the decimal point indication for the ratio is not true unless the 10 or 100 Hz RESOLUTION (MHz readout) push-button is selected, and that the gate time is longer for greater resolution measurements. If the EXT. IN frequency is relatively low, then the gate time may be several minutes.

LP filter

6. Switch the low-pass filter in to reduce errors when making low frequency measurements.

Self check procedure

7. A simple test to show that the instrument is working correctly can be performed by using it to measure its own standard output. This does not, of course, verify the accuracy of indication since any error in the standard will be cancelled by a corresponding error in the gate time which is derived from the same source. This test cannot be used to check the instrument at .01 Hz resolution.

8. To do the test, proceed as follows.

(1) Connect the 1 MHz STD. OUT socket to the Channel B input socket and terminate the signal into 50 Ω using a T-connector.

(2) Select each RESOLUTION push-button in turn (except .01 Hz) and check that the display reading is within 1 count of the corresponding illustration of the display in Fig. 3.

9. To check the instrument in the .01 Hz resolution mode, connect to the Channel B input socket a 1 kHz signal (or any convenient, known frequency of less than 5 kHz). Select the LFM Hz push-button to give .01 Hz resolution. Check that the display (in the case of a 1 kHz input signal, and allowing for possible error) corresponds to the top illustration of Fig. 3.

Display digit check

10. Release all RESOLUTION push-buttons to check illumination of all digit segments and decimal points.

Chapter 4-1

BRIEF TECHNICAL DESCRIPTION

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INTRODUCTION

1. The following brief technical description should be read with reference to the simplified block diagram shown in Fig. 1.

10 HZ - 200 MHZ INPUT

2. The input signal is fed into an input buffer comprising a dual gate m.o.s. f.e.t. and emitter follower whose gain and, for high level signals, attenuation can be controlled by a d.c. voltage applied to the m.o.s. f.e.t. The output of the buffer is detected and converted into a proportional d.c. voltage which controls the buffer.

3. The output signal from the subsequent wide band amplifier is of constant amplitude and its level just exceeds the hysteresis window of the Schmitt trigger thus ensuring reliable triggering even when the signal has a poor signal-to-noise ratio.

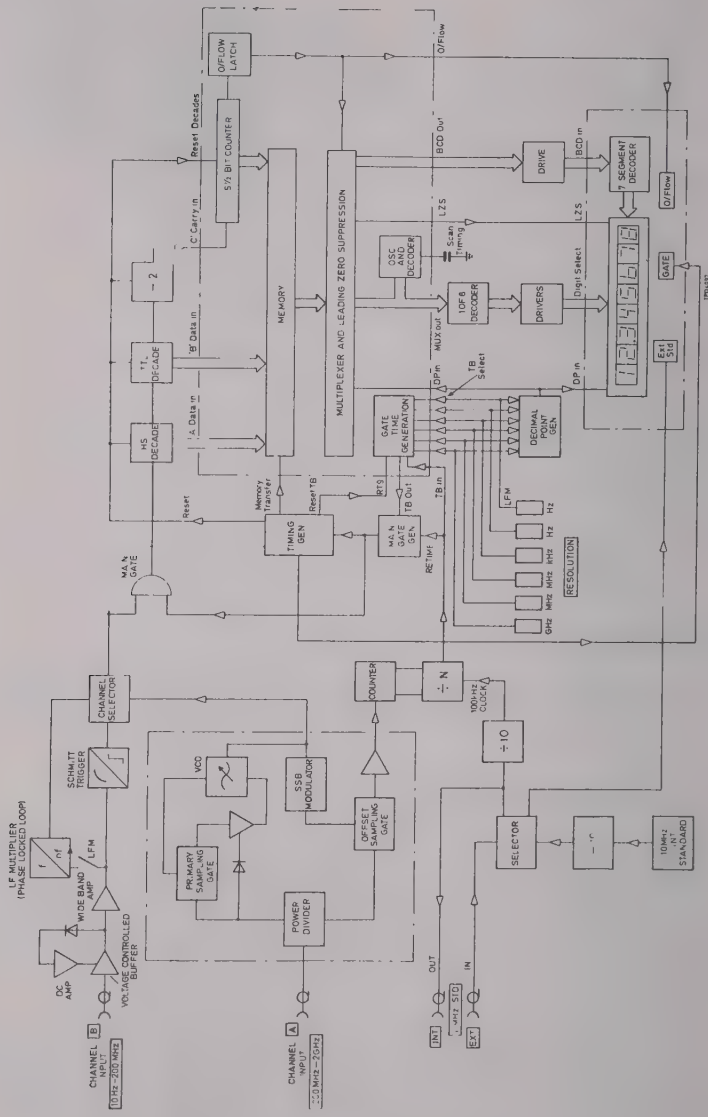

Fig. 1 2435 block diagram

4. The output from the Schmitt trigger is selected by the channel selector and fed through the main gate to the high speed i.c. decade. The pulse train input is counted by an eight decade counter, two and a half decades of which are discrete i.c's and the remainder part of a custom designed l.s.i. m.o.s. i.c.

200 MHZ - 2 GHZ INPUT

5. The signal input is fed to a transfer oscillator unit which converts the input frequency to a sub-harmonic and also determines the harmonic number N. The sub-harmonic is fed to the main counter while the harmonic number N is used to control the time base frequency. Gate time is therefore lengthened by a factor of N which enables the display to indicate the signal input frequency.

6. The input circuit comprises a p.i.n. diode limiter and a power divider which splits the signal to feed the two sampling gates.

7. The primary sampling gate is driven by a voltage controlled oscillator. The gate output is detected and used to drive a gain controlled amplifier which feeds the v.c.o. VCO output (sub-harmonic) is fed to the main counter gate and also to the single sideband modulator in the offset sampling circuit.

8. The modulator is driven by two phase shifted signals generated in the main frame. The resultant frequency drives the offset sampling gate whose output is amplified and fed to the harmonic N counter.

9. The resulting value for N programs a frequency divider operating on the 100 kHz clock input and the divided output provides the time base frequency fed to the gate time generator. The contents of the counting circuits are transferred to the display which indicates N times sub-harmonic frequency, that is the signal input frequency.

CLOCK SELECTION AND GATE GENERATOR

10. An internal 10 MHz crystal oscillator, frequency divided by 100 generates the counters 100 kHz main reference clock. This can alternatively be introduced from a 1 MHz source via the EXT. STD. input socket which will automatically override the internal standard.

11. The clock signal is fed via the N divider to the gate time generator which is incorporated in the main integrated circuit. For channel A inputs the clock frequency divisor N, is dependent on the signal input frequency. For channel B inputs N = 1 and generator input frequency is 100 kHz.

12. The gate time generator divides down by a ratio determined by the RESOLUTION switches to produce a time base output. The time base output is divided by two and retimed from the clock signal to ensure accuracy. Monostable integrated circuits generate a timing sequence which determines display time, memory transfer and reset times.

LOGIC CIRCUIT

13. A custom designed l.s.i. m.o.s. integrated circuit is the heart of the counter and contains all the digital logic that does not need to run at high currents or speeds.

14. The i.c. contains a $5\frac{1}{2}$ decade counter with overflow latch and an eight decade memory. Two and a half decades of the memory have a parallel data loading capability to enable the i.c. to be used with higher speed logic. The data from the memories are fed into a multiplexer which is controlled by an on-chip oscillator and 1 of 8 encoder. A signal for providing leading zero suppression is generated in the i.c. The 40 pin package also contains a time base section comprising a seven decade divider and a 1 of 7 data selector.

SWITCHING

15. For channel B input the front panel push switches select one of six gate times. The 1 ms, 10 ms, 100 ms, 1 s and 10 s and 1 s gates give display resolutions of 1 kHz, 100 Hz, 10 Hz, 1 Hz, 0.1 Hz and .01 Hz respectively and determine the decimal point position.

16. For channel A input the resolutions available are 1 kHz, 100 Hz, 10 Hz and 1 Hz. Gate times are dependent on the input frequency and thus the 1 ms, 10 ms, 100 ms or 1 s times are increased by a factor of approximately

$$\frac{\text{input frequency}}{35\ \text{MHz}}$$

DISPLAY BOARD

17. The display board contains the 7-segment l.e.d. displays and b.c.d. to 7-segment encoder with its associated current limiting resistors. The board requires 1 of 8 digit drive multiplexed b.c.d. information, a decimal point signal and leading zero suppression signal. Three lamps are mounted on this board and indicate GATE period, OVERFLOW and EXTERNAL STANDARD operation.

2435

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